U.S. Department of Agriculture Agricultural Research Service
April 1982



# Agricultural Research

# Agriculture Day

With the celebration of Agriculture Day this year, there is special recognition of the millions of agricultural workers—the farmers and ranchers, the producers and processors, the local businessmen and women who have made agriculture the Nation's number one industry.

As honorary chairman of the March 18 observance, Secretary of Agriculture John R. Block said, "Every American should be proud of this Nation's tremendous record of agricultural achievements. It is a vital part of what makes America the great country that it is."

Agriculture employs about 1 out of every 5 Americans and provides 20 percent of the Nation's output. Last year there were $44 billion worth of U.S. agricultural exports. These exports created at least another $49 billion of additional business in the nonfarm community. American agriculture's assets exceed $1 trillion.

Most of the world's grain and soybeans come from American agriculture. As the world's largest producer and supplier of agricultural products to world markets, American agriculture is essential to maintaining a favorable U.S. competitive position in international trade.

At the same time, American agriculture has been a vital part of emergency world food relief and has lent assistance to other nations in adapting agricultural technology for their own development.

Agriculture Day celebrates American agriculture's success in providing the world's most abundant and highest quality food supply.

There are many stories behind this success. The contribution of agricultural research is a critical one. In the last 30 years, research has changed the face of crop production, improved animal productivity, and increased technological efficiency.

Major research accomplishments have led to such developments as disease- and climate-resistant hybrid varieties, new foods, chemical and biological pest control techniques, innovative conservation tillage, soil erosion and water management practices, control of animal disease, and advances in agricultural technology. Research has led to the production of higher quality and nutritious food, efficient processing, and more effective transportation and storage.

Agricultural research is now searching such new frontiers as genetic engineering, genetic breeding and embryo transfer, cloning, germplasm development, integrated pest management, natural growth regulation, improving photosynthesis efficiency, and computer technology to meet the challenges facing agriculture today. These challenges will become greater as food shortages become apparent and the demands for food increase worldwide.

The challenges to agricultural research stem from concerns over soil erosion (some 2 billion tons of soil are lost annually from surface runoff on cropland); loss of farmland (1 million acres of prime farmland are lost to nonfarm purposes yearly); loss of groundwater to irrigated agriculture; degradation of the environment; pesticide use; increased fertilizer costs; and availability of energy supplies and increasing energy costs.

Soil deterioration and water shortages may well take the lead over energy as a crisis issue during the next two decades. River basins are polluted by sediment in almost every water resource region. Erosion from cropland makes up nearly half the total sediment. Most new cropland to meet future demands for food and fiber will have to come from existing pasture or forest land.

Key issues in new research are applying agricultural technology to the basic mechanisms of soil erosion and finding new irrigation and water-conserving techniques for cropland.

The primary challenge of agricultural research, then, is to maintain and improve the Nation's technology base to increase agricultural productivity so that American agriculture can continue to provide a positive position in the Nation's world trade balance without depleting our resources.

To meet this challenge, American agriculture depends on the expanding of cooperation within the total agricultural research system, which includes USDA's Science and Education agencies, other Department and Federal cooperators, private universities, industry, and other research organizations.

Rosemary Wolfe
Washington, D.C.

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Cover: ARS entomologist K. Duane Biever finds a cabbage looper killed by a naturally occurring fungus. At the Biological Control of Insects Laboratory, Columbia, Mo., Biever studies such biological agents to control pests of truck crops. (1281X1590-19a)

# Chemical Gives Seeds "Get-Up-And-Grow"

Ever heard of polyethylene glycol? It's a chemical used in a host of industrial processes, and now research by two USDA scientists suggests it may increase yields of soybeans and other legumes.

Lowell W. Woodstock and Kar-Ling James Tao of USDA's Beltsville Agricultural Research Center in Maryland have found that soaking the embryo of soybean seeds with polyethylene glycol (PEG) will improve the germination and early growth of aged or damaged seeds. In some cases, the effects of aging are almost completely avoided.

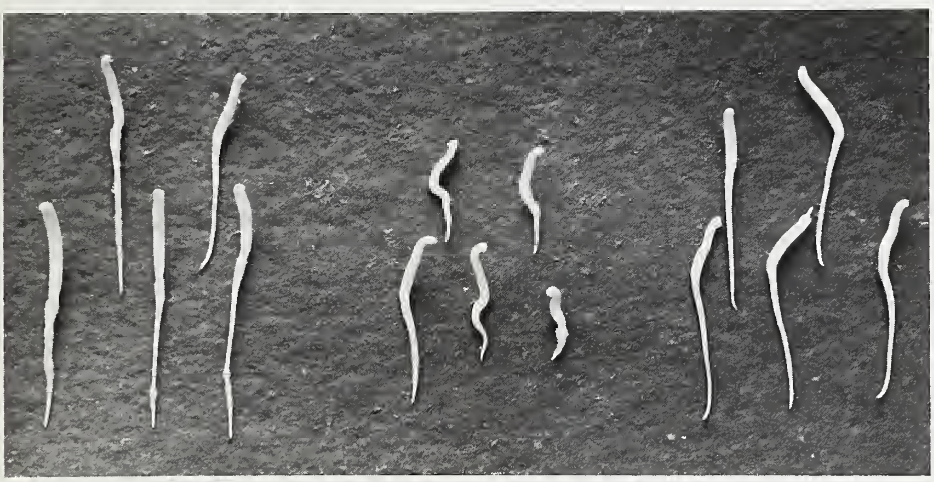
Woodstock and Tao found that proper germination and early growth depend partly on the seeds' ability to withstand rapid uptake of water immediately after planting. If the cell

**Above left:** Kar-Ling James Tao measures the electrolytes released by soybean embryos. Low-vigor embryos release more electrolytes than high-vigor embryos. (0182W024-26)

**Above:** Sauna for seeds: Kar-Ling James Tao prepares soybean seeds for rapid "aging," a process that simulates long-term open storage. (0182W024-3)

**Left:** Lowell Woodstock (right) discusses growth of soybean embryos with assistant Keith Furman, graduate student, University of Maryland. (0182W025-31a)

**Below:** Embryos (excised from dry soybean seeds) after 5 days in an artificial growth medium: left, from high-vigor seeds; center, from low-vigor seeds; right, from low-vigor seeds soaked in PEG. (0182W025-12)



membranes have deteriorated because of age or damage, they tolerate water uptake less, and the swelling caused by water can further injure the membranes.

"The seed's embryo appears to be the critical component when injuries occur from the rapid influx of water," says Woodstock, who is with the Seed Research Laboratory of Beltsville's Plant Genetics and Germplasm Institute.

During the first minutes of exposure to water, aged embryos lose six times more of the cell constituents than young, healthy embryos lose, Woodstock and Tao found. These may include the enzymes, nucleotides, amino acids, and organic and inorganic ions needed for the seeds' life processes.

In the experiments, PEG-treated embryos (from seeds which had first been "aged" by storing for up to 5 days at 106°F and 100 percent humidity), grew at a rate comparable to that of high-vigor embryos.

Woodstock and Tao theorize that PEG slows the seeds' water uptake, possibly giving cell membranes time to repair, thus reducing the leakage of cellular constituents. Cell membranes are semipermeable, allowing smaller molecules such as water to enter while blocking larger molecules such as PEG. PEG's presence reduces the effective concentration of water molecules, and fewer water molecules hit (and pass through) the cell membrane in a given amount of time.

Although he reaffirms that there is no substitute for high-vigor seeds, Woodstock believes that polyethylene glycol might substantially increase the yields of soybeans, lima beans, peas, and other crops whose seeds are susceptible to such injury—particularly when planting is followed by a cold spring rain.

Subsequent work by Woodstock and colleague Raymond B. Taylorson into PEG's effects on whole seeds has supported these findings. Results indicate that the chemical could also solve problems with the practice of soaking seeds in water before planting. Soaking encourages uniform and rapid germination, but it also causes some seeds considerable injury. In Beltsville tests, low-vigor soybean seeds not only were protected from soaking injury when PEG was added to the water, but also actually grew better than PEG-treated, low-vigor seeds not soaked in water.

Work at the Boyce Thompson Institute in Ithaca, N.Y., has been equally encouraging, showing that a coating of PEG and gum arabic protects soybean seeds against chilling injury. "Gaps between the laboratory experiments and the actual field use of polyethylene glycol remain to be filled," Woodstock says. "But the results thus far suggest that we're on our way to improving soybean and other legume yields."

Lowell W. Woodstock is located in Room 12-A, Building 006, Agricultural Research Center, Beltsville, MD 20705. Kar-Ling James Tao is with the Seed Standardization Branch, Agricultural Marketing Service, Beltsville, MD 20705.—(By Andy Walker, Beltsville, Md.)■

# Plants and Insects React to Space Shuttle Exhaust

ARS scientists have been cast in an important new supporting role in a favorite American drama—space shuttle launches from John F. Kennedy Space Center.

The somewhat unusual role, far from "show business," has taken 3 years of painstaking research.

At the request of the National Aeronautics and Space Administration (NASA), ARS scientists, working with scientists at North Carolina State University, investigated the effects of exhaust clouds generated by shuttle launches at Merritt Island, Fla. They evaluated the shuttle's possible influence on native plants and insects, on a commercially important beekeeping industry, and on large citrus groves in the area. Citrus is a major crop on Merritt Island, worth $7.2 million annually.

The area around the shuttle launch site is part of the Merritt Island National Wildlife Refuge. "The Island is a mosaic of different coastal ecological communities," says ARS plant physiologist Walter W. Heck, who led the cooperative research which resulted in the first of two reports to NASA.

Because preliminary investigations showed that hydrogen chloride gas is the major plant toxin in solid rocket fuel, Heck's team began by showing that aluminum oxide or alumina and hydrogen chloride gas were the most likely components of exhaust from solid rocket fuel to harm biological systems.

Greenhouse exposure chambers were continuous-stirred-tank reactors, which assure that conditions inside are uniform. They were built and tested for use with hydrogen chloride gas. One chamber had a dispensing system for alumium oxide or alumina particles.

Also, a controlled burn facility was designed and tested by North Carolina State University engineering graduate student Allen H. Sawyer. The facility exposed plants to solid rocket fuel exhaust in tall field chambers. The field chambers were modified from the standard open-topped chambers that are often used in air pollution studies. With the modifications, they had a top but no stirrer; other changes assured that conditions were nearly uniform inside.

Twenty-four plant species native to Florida were grown in the greenhouse. They were screened for sensitivity to hydrogen chloride, aluminum oxide, mixtures of aluminum oxide and hydrogen chloride, and solid rocket fuel exhaust.

Exposures of selected plants to large doses of aluminum oxide (50 milligrams per cubic meter during a 60-minute period) did not cause injury or affect growth. Plants responded to mixtures of aluminum oxide and hydrogen chloride in the same way they did to hydrogen chloride alone—the threshhold concentration for injury was 3 to 4 parts per million (ppm) for an 80-minute exposure.

Solid rocket fuel exhaust mixtures were monitored by deterimining the hydrogen chloride concentations in the field chambers while solid rocket fuel was being burned. Results from exposing plants to the exhaust mixtures corresponded to results from comparable greenhouse exposures to hydrogen chloride.

"Although insects are an important part of all ecosystems," says Heck, "they have been largely overlooked in air pollution studies."

For the NASA investigations of solid rocket fuel exhaust, representative insect species were chosen: a pollinator, the honey bee; a predator, the common lacewing, which preys on a number of citrus pests; and the ubiquitous corn earworm, which damages many field and garden crops. All are found on Merritt Island.

An effective lethal dose, $ED_{50}$, is defined as a dose that causes 50 percent of the insects to cease movement. It generally means death but does not prove it.

The $ED_{50}$ of hydrogen chloride for forager honey bees was 100 ppm for 120 minutes, and 150 ppm for 30 minutes. The $ED_{50}$ for lacewing larvae was 150 ppm for 60 minutes, and that for the most sensitive life stage of the corn earworm, 102 ppm for 60 minutes.

Brood production of active bee colonies was only temporarily affected by multiple exposures to solid rocket fuel exhaust at hydrogen chloride concentrations of 10 ppm. Multiple exposures of bee colonies to 20 or 30 ppm, however, caused a loss of brood production. When exposures ended, brood production started to increase, but 2 of the 4 colonies ultimately were lost.

The results of these studies suggest that no direct observable acute effects on insects will be found as a result of the space shuttle program. The harmful doses are higher or more prolonged than those the shuttle actually causes. However, exposed honey bee colonies could suffer stress-related diseases, says Heck.

In a second report, researchers headed by plant pathologist Allen S. Heagle determined the response of citrus to simulated "rain" acidified with solid rocket fuel exhaust or with hydrochloric acid.

"There are no reports on the effects of acid rain on plants where the acidity is caused principally by hydrogen chloride," said Heagle. Therefore, researchers sprayed hydrochloric acid solution on mature Valencia orange trees in a commercial grove at Merritt Island and on pottted trees at Raleigh. Trees sprayed with pond water were used as controls.

In measuring acid levels, a pH of 7 is neutral. Acid at pH 2.0 caused visible symptoms on flowers, leaves, petioles, stems, and immature fruit; injury was moderate at 1.0 and severe at 0.5.

Calamondin plants are an ornamental citrus that produce small fruit year round and are commonly used in

greenhouse research. Potted calamondin plants were exposed to hydrogen chloride solutions at pH 1.1 or 0.7 applied as "rain" during flowering or after fruit set. Deionized water was the control.

Calamondin reacted to hydrogen chloride solutions in much the same way that mature Valencia oranges did. Potted Valencia oranges at Raleigh reacted similarly to the grove oranges in Florida.

In order to treat several plant species, the solid rocket fuel exhaust system was redesigned by North Carolina State University engineering graduate student Randy Perry to force solid rocket fuel emission through a "rain" tower. To acidify the simulated rainfall to various degrees, different amounts of fuel were burned and the emissions collected. The simulated rainfall then passed through the emissions. Marsh elder, radish, and soybeans were more sensitive than calamondin plants.

The results suggest that near launch areas where solid rocket fuel is used, plants will be injured if hydrogen chloride rain occurs having acid levels below pH 2.0.

"We expect that direct damage to citrus will be minor, unless the same area is repeatedly affected," Heagle says. In fact, mature Valencia orange trees that were severely injured by hydrogen chloride solutions at pH 0.5 in 1978 yielded as much in 1980 as did the controls.

The 3-year research study was supported through an Interagency Agreement with NASA, and cooperatively done by ARS and North Carolina State University.

NASA was represented by plant physiologist William M. Knott, in charge of the Environmental Monitoring Program for the Kennedy Space Center. Knott's coded mailing address is MD-RSB-B, John F. Kennedy Space Center, FL 32899.

Walter W. Heck and Allen S. Heagle are located at North Carolina State University, P.O. Box 5847, Raleigh, NC 27650.—(By Peggy Goodin, New Orleans, La.)■

Exhaust clouds blanket the surrounding area as Space Shuttle Columbia lifts off from the launch pad at Merritt Island, Fla. (Photo 81-H-1120, courtesy of NASA)

**Above:** Female parasitic wasps *Ptermalus puparum* lay eggs in the imported cabbage worm. The tiny wasps (less than ¼ inch long) are being evaluated as a potential control agent. (1281X1578-17)

**Above right:** An immature predatory stink bug (about ½ inch long) feeds on a cabbage looper larva. (1281X1577-14a)

**Right:** A naturally occurring virus has almost killed this cabbage looper. (1281X1585-42a)

A radio-controlled model airplane flies over a cabbage field near St. Louis, spraying drops of virus-laden material to eventually infect the larval offspring of cabbage looper moths.

That scene will be implemented this spring by ARS entomologist K. Duane Biever of the Biological Control of Insects Laboratory, Columbia, Mo., and Roy Baker, president of the local Radio-Controlled Model Airplane Club. Last fall they ran a flight test and evaluated the liquid-spray delivery system, which is battery powered.

"The idea of this experimental program is to create hot spots of infection in the field and then determine how effectively the virus spreads to infect cabbage loopers throughout the field," says Biever.

The virus infects only cabbage loopers.

Cabbage loopers from noninfected areas of the field will be a source of food for parasites and predators. Then as the virus spreads, it will be one of several pests controls in a balanced ecosystem of integrated pest management (IPM).

"The model airplane seemed like a practical and fun way to get the job done," says Biever. "This past year, which was extremely wet, would have been an excellent time to have had this

In a flight test of its efficiency, the radio-controlled model plane sprays a flourescent dye onto cabbages and target cards. (1281X1576-31a)

system available, as growers often could not get through their fields to spray at the right time."

Spreading viruses to vegetable pests with a model airplane is just one of the control strategies that Biever is studying. He and his colleagues are conducting IPM research on 10 farms in the St. Louis area involving the cole crops, cabbage, cauliflower, broccoli, and greens. Pest control strategies include cultural practices, resistant plant varieties, and even prudent recourse to some chemical insecticides.

"IPM programs that maximize biological controls seem most promising for long-term regulation of pests below economically damaging levels," Biever says.

In addition to using a model airplane, Biever is enlisting the help of laboratory-reared spined soldier bugs, which are predatory stink bugs, to spread viruses to cabbage pests. He's also experimenting with parasitic wasps and flies.

Another way of getting viruses and damaging insects together that appears promising is distributing the disease organisms through sprinkler irrigation sytems, Biever says.

Many viruses and other entomopathogens survive from season to season in the soil, according to the researcher. Tillage of the soil at appropriate times might bring the soil and entomopathogens into contact with larvae on plants, initiating widespread infections.

One entomopathogen that Biever has found most effective for pest control in cabbage fields is the bacterium *Bacillus thuringiensis* (BT). In the late 1960's Biever and ARS entomologist Donald L. Hostetter conducted research in commercial cabbage fields near St. Louis that showed 20 to 25 applications of chemical pesticides throughout the growing season could be replaced by 6 to 8 timely applications of BT.

BT should not be applied too frequently or too heavily, Biever stresses. If it kills too many harmful insects, then predators and parasites cannot survive in sufficient numbers to prevent a resurging of pest populations, which could then quickly loom large.

A few growers with whom he worked a decade ago are still using BT, but many growers, pressed by lack of time to examine their fields regularly for pests, rely on scheduled chemical spray programs.

During the past 2 years, however, several growers have become involved wth an IPM research program to achieve maximum effectiveness of biological control.

The research on keepng pest populations small and stable could help growers produce cabbage and other vegetables more economically than they now do. To help achieve this goal, Biever is collaborating with specialists in the Missouri Extension Service and the University of Missouri departments of entomology, horticulture, and plant pathology.

K. Duane Biever is located at the ARS Biological Control of Insects Research Unit, P.O. Box A, Columbia, MO 65205.—(By Ben Hardin, Peoria, Ill.)■

# Victims of the Fire Ant—A Survey

About 60 years ago a few illegal insect aliens, commonly known as fire ants, were first discovered in the port city of Mobile, Ala., far from their home in central South America.

Today, with as many as a quarter of a million aggressive, stinging ants to a single colony, the imported fire ant has spread over 230 million acres in nine states.

Although the widespread destruction caused by fire ant mounds in farmlands and woods is well known throughout the South, the fire ant sting leaves an even more painful reminder with its victims (see "A Super Colony," *Agricultural Research*, July, 1974, p. 12). Not surprisingly, these ants are receiving increasing attention from the medical profession and related sciences.

The red and black fire ants (*Solenopsis invicta* Buren and *S. richteri* Forel) have colonized Mississippi, Alabama, Georgia, Florida, North and South Carolina, Texas, Louisiana, and southern Arkansas. They were also reported this year for the first time in Puerto Rico by William Buren, entomology professor at the University of Florida.

ARS entomologists Claude T. Adams and Clifford S. Lofgren conducted a survey to compare sting and bite rates of arthropods among military and dependent personnel at Ft. Stewart, Ga. Special emphasis was on the economic and public health impact of imported fire ants.

In excess of 250,000 acres, Ft. Stewart is criss-crossed by unpaved roads serving areas used for routine and special military maneuvers, and for bivouac areas for field training. Populations of the red imported fire ant have become well established at Ft. Stewart since the last insecticide treatment, which occured in 1971—a single application of mirex, banned since 1978.

Adams and Lofgren found that, based on data supplied by the Office of the Surgeon General, U.S. Army, the cost of treating all arthropod bites at Ft. Stewart amounted to about $10,000 for the 6 months from April through September, 1979. During the warm season, personnel received maximum exposure from work or recreation.

Recently Adams and Lofgren reported in the Journal of Medical Entomology that about 35 percent of the population in Sumter County, Ga., was stung once or more during 1 year. The sting rate was highest, 50 percent, in persons less than 20 years old, and showed an age-related decline.

Adams and Lofgren also cite medical studies by private physicians and a physician with the Medical College of Georgia published in 1973, 1975, and 1977 that described allergic reactions, cases of hypersensitivity, and sting rates caused by imported fire ants. Symptomology included urticaria (itching skin eruptions or pustules), 84 percent; generalized angio-edema (watery swelling involving the blood vessels), 78 percent; respiratory distress, 50 percent; gastrointestinal involvement, 11 percent; and shock reactions, 16 percent.

At the time of the ARS scientists' survey, the population at Ft. Stewart consisted of 12,000 active-duty military personnel and 11,000 dependents, with 75 percent of the active-duty personnel 18 to 44 years old.

Both patients and medical personnel at the dispensaries and emergency room answered questionnaires for six categories of bites or stings: imported fire ants, wasps, bees, spiders, other, and unknown. Medical personnel indicated severity, symptomology, and secondary infection.

For the 329 paitents treated for arthropod bites or stings, a total of 370 visits were required, including 7 days of hospitalization.

Approximately 50 percent of the patients were known to be stung by the red imported fire ant; 26 percent could not identify the arthropod responsible for the attack; and the rest were attributed to wasps, bees, spiders, mosquitoes, ticks, chiggers, and fleas (1 to 5 percent each).

Pustule formation was seen in 88 percent of the patients who reported they were stung by the red imported fire ant. In addition, 55 percent of those patients reporting stings by unknown species reported pustule formation.

In the opinion of Dr. R. B. Rhoades, Assistant Professor with the Medical College of Georgia, cited by Adams and Lofgren, pustule formation is presumptive evidence that the sting was from an imported fire ant. Therefore, this insect may have been responsible for attacks on many of the people who couldn't identify the attacking arthropod.

About 40 to 60 percent of the reactions to all bites and stings except those of ticks and fleas were considered moderate or severe. Surprisingly, say Adams and Lofgren, none of the patients stung by bees or wasps in this survey expressed shock symptoms, although 8 persons (5 percent) stung by the red imported fire ant exhibited symptoms of shock compared to 1 each for mosquitoes, ticks, and unknown arthropods.

Nine symptoms were identified for 278 of the patients who requested treatment. No symptomatology was reported for the other 51 patients treated for arthropod bites or stings.

The most frequently treated symptoms were edema (82 percent), urticaria (43 percent), and respiratory distress (5 percent).

Based on medical cost data from the Office of the Surgeon General, U.S. Army, a single outpatient visit cost $23.10, and hospitalization $176.45 per day.

Imported fire ants were responsible for 49 percent of the outpatient visits caused by arthropods ($4,188) and 71 percent of the hospitalization costs ($892), for a total of $5,070.

Claude T. Adams and Clifford S. Lofgren are with the Insects Affecting Man and Animals Research Laboratory, 1600 S.W. 23rd Drive, P.O. Box 14565, Gainesville, FL 32604.—(By Peggy Goodin, New Orleans, La.)■

# Corn Cobs for Corn Drying

Half the cobs from a field of corn can provide enough energy to dry all of the grain crop.

ARS and Purdue University researchers are converting the cobs to heat in a process known as gasification, which includes reduction, pyrolysis, or destructive distillation. They're burning the gases to get a clean hot air exhaust with which to dry the corn directly.

"The close-coupled gasification-combustion process helps us obtain the maximum amount of usable energy we can get from the cobs," says ARS agricultural engineer John R. Barrett, Jr.

Other biomass materials besides cobs that the scientists have run through the gasification furnace include sticks, wood chips, straw, leaves, and corn stalks. The researchers will determine the energy that can be obtained from biomass and will provide the engineering design and operational guidelines to make the gasifier's use safe, efficient, and economical.

The furnace that the researchers are developing produces up to a million BTU's per hour. That's more than the amount of energy in 7 gallons of fuel oil.

It takes about 15,000 BTU's to dry a bushel of corn from 26- to 15.5-percent moisture content. That's about twice the energy usually required to produce and harvest the corn, not including energy to produce fertilizer and herbicides.

Barrett says the heat produced from biomass furnaces could also be used to heat farm homes or other farm buildings.

The gas produced during gasification consists mostly of carbon monoxide, hydrogen, carbon dioxide, and nitrogen, with a little methane, argon, and water vapor. It is similar to the "producer gas" that many Europeans used to power their cars during World War II when gasoline was not available. It's also similar to natural gas but with only 10 to 15 percent of the energy content, says Barrett.

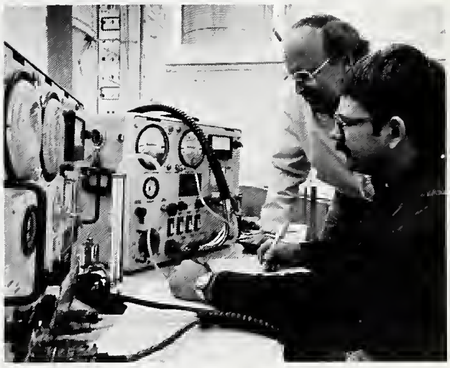
Briefly, here's how the two-stage furnace for gasification and gas burning works: Biomass is placed or stoked into an oxygen- and heat-controlled chamber and ignited with a flame. Within a few minutes the flame dies out, as oxygen becomes limited. The gas that is made under conditions of controlled heat and oxygen moves down through the channels or valleys of the chamber floor and exhausts into a secondary combustion chamber that is lined with firebrick.

Charles Hipsher, student employee, loads corn cobs onto a conveyor that dumps them into the gasifier, tended by Clarence Richey. (1281X1533-21a)

As soon as the hot gases enter the secondary chamber where oxygen is abundant, they ignite. The gases burn with a colorless flame at a temperature around 1,300°C (2,400°F), producing a hot air exhaust that is blended with cool air and then piped to the corn.

Purdue University researchers working on the energy utilization project include agricultural engineers Clarence B. Richey, Robert M. Peart, and George H. Foster. Environmental engineer Robert B. Jacko is studying the potential of the gases to contaminate agricultural products and the environment.

The studies at Purdue University are complemented by computer studies in which ARS scientists in Minnesota have shown that all agricultural residues produced in the United States could supply 1 to 2 percent of the Nation's energy demand. Less than 4 percent of the Nation's energy is used on farms.



Project leader John Barrett, left, and Robert Jacko monitor equipment testing exhaust from the gasifier and from the corn during drying. (1281X1534-26a)

The research in Minnesota identified areas of the Corn Belt where removal of all residues for energy or other competing uses would cause serious soil erosion. However, if farmers used no-tillage conservation practices, nearly half of the residues could be removed from 74 percent of the Corn Belt acreage.

John R. Barrett, Jr., is located in Room 306, Agricultural Engineering Building, Purdue University, W. Lafayette, IN 47907.—(By Ben Hardin, Peoria, Ill.)■

Test plots of several different weeping lovegrass strains. (PN-6831)

Three ARS researchers are taking different paths to achieve better forage production on our grasslands.

On the Southern Great Plains both native and introduced grasses are difficult to establish because surface soil can dry to the wilting point within one day. Planting germinated grass seeds may be the easiest and most economical method to obtain a good grass stand in this semiarid area, according to ARS research engineer Victor L. Hauser. Hauser described three nonconventional methods of planting grass that he is testing—bandoleer planting, punch planting, and germinated-seed planting.

In bandoleer planting, the grass is grown in plastic strips with pockets that hold growth medium in which the plants are grown from seed. The strips are taken to the field for transplanting. The bandoleer method looks promising, but will require a high degree of mechanization.

In punch planting, the seeds are placed in holes four times deeper than those conventionally used to avoid drying. Hauser got good results from that method, but he said that presently this practice would be limited by a lack of satisfactory equipment to do the job on a large scale. Also, a surprise rainfall could fill the holes with soil and prevent the plants from emerging.

Referring to both punch and bandoleer planting, Hauser said, "The ultimate use of these methods will depend upon the quality and cost of machines that are yet to be developed."

Planting germinated seeds may be the best method to use now and in the immediate future. However, all three of the new methods tested produced stands superior to those from conventional planting methods.

Hauser tested weeping lovegrass, kleingrass, and TAM wintergreen hardinggrass in his 3-year study.

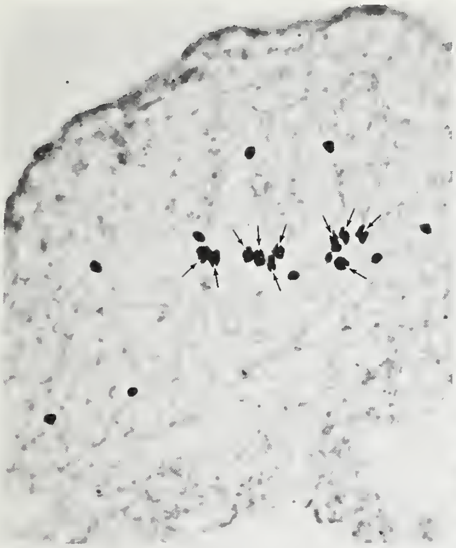
"A significant improvement in the probability of success in grass establishment would make good range and pasture management more feasible in the Southern Great Plains," the scientist said.

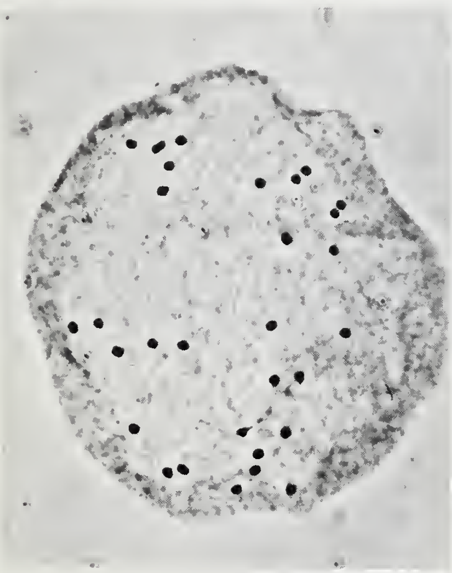
Taking another path, ARS research geneticist Byron L. Burson is attempting to overcome apomixis and break a strong natural barrier that stands in the way of improving dallisgrass, an important forage grass.

Apomixis is a "sealed" asexual method of reproduction once considered an evolutionary dead end. In apomixis, the plant produces seeds, but cross-fertilization and the recombination of new characters in the offspring are impossible, which makes improvement of the grass impossible by conventional means. Burson is trying to "resynthesize" or genetically reconstruct the dallisgrass species to overcome the apomictic barrier.

If Burson can identify the ancestors of common dallisgrass, he hopes to cross these ancestors to produce or resynthesize a sexual dallisgrass plant. Using a sexual yellow-anthered form of dallisgrass, he has identified two of its ancestors and only a third remains to be identified.

If he is successful, new forms of dallisgrass would be available for plant breeders to use to improve this forage, thus overcoming undesirable charac-





teristics such as poor seed quality and susceptibility to disease.

ARS geneticist Paul W. Voight is approaching better forage production by developing a new breeding plan to improve weeping lovegrass and boer lovegrass, important forage grasses in the arid and semiarid southwestern United States.

At one time, lovegrass was thought to reproduce only by apomixis. Thus, the plant would remain genetically the same generation after generation. However, in 1971 Voight discovered that some lovegrass types reproduce sexually. This discovery makes plant breeding and improvement possible.

"Although many questions concerning apomixis remain," says Voight, "clearly apomixis is no longer an important barrier to breeding lovegrass." In fact, apomixis is an asset, because once the desirable characteristics, such as cold hardiness and drought resistance, are obtained they are "sealed in," which would give ranchers a true-breeding hybrid. Thus, each plant generation would remain unchanged and retain its desirable qualities without further breeding effort. Conventional hybrids require new seed production each generation.

Victor L. Hauser, Byron L. Burson, and Paul W. Voight are located at the Grassland, Soil and Water Research Laboratory, P.O. Box 748, Temple, TX 76501.—(By Bennett Carriere, New Orleans, La.) ■

**Left above:** Chromosome pairing (arrows) between yellow-anthered dallisgrass and *Paspalum intermedium* shows that the two grasses are close relatives. (PN-6829)

**Left below:** In a cell from a hybrid of yellow-anthered dallisgrass and *Paspalum vaginatum*, lack of chromosome pairing shows that the two species are not closely related. (PN 6828)

**Above:** A healthy blue grama plant in spring, 10 months after transplanting. Seedlings grew equally well with and without the plastic bandoleer casing on the root plug. (PN-6827)

# Self-Cleaning Seed Separator

An indent cylinder type of seed separator that cleans itself has been designed and successfully tested in a project funded by ARS.

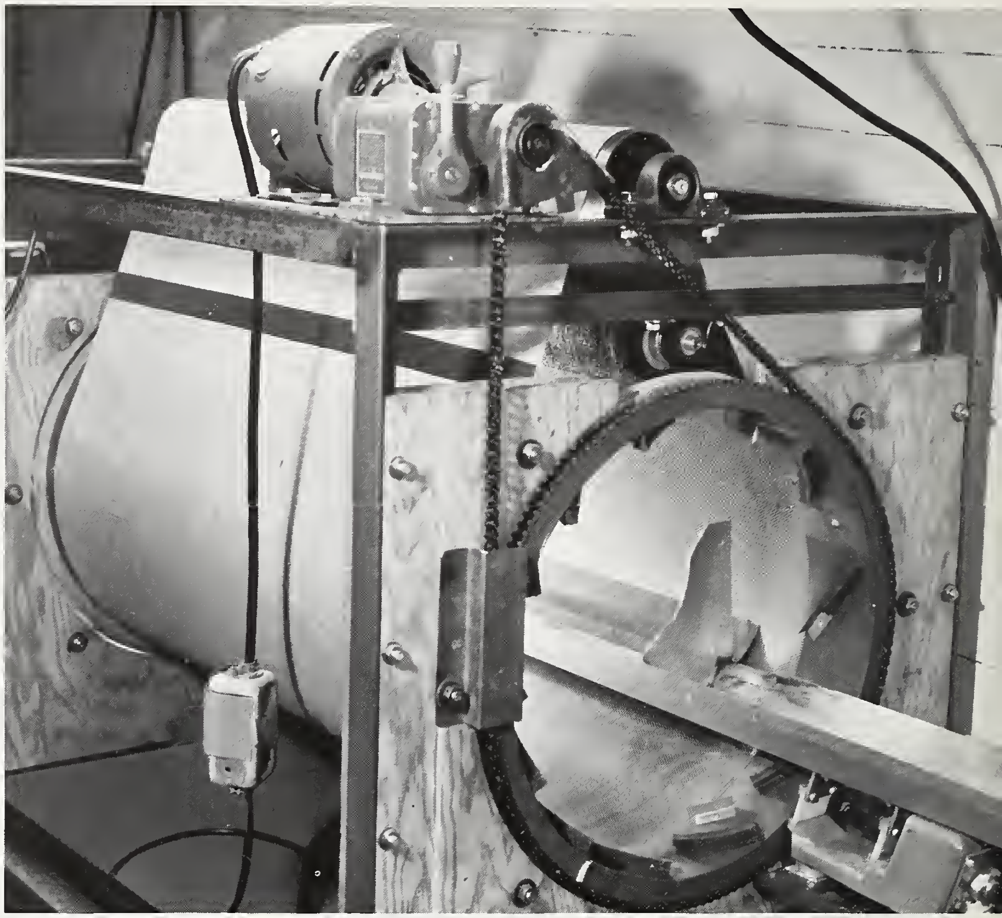
Allen Maier, a student engineer with Oregon State University, Thomas McNeil Cooper, an OSU researcher, and ARS engineers Joseph K. Park and Norman R. Brandenburg, all at Corvallis, Oreg., have made key modifications to an indent cylinder that prevent seed from clogging up the indents.

Seed as it comes in from the field is mixed with weed seed and other contaminants. To meet quality standards, the good seed must be "cleaned," or separated from such contaminants.

Indent cylinders separate seed on the basis of length. Holes designed to fit a specific length of seed are punched into a special cylinder, which is then wrapped with a metal backing to form indentations that can hold and carry the seed. When the cylinder is rotated, seed meeting the length specifications is swept up by the indentations and deposited into a container. Sometimes, however, the indentations get plugged up by seed.

To overcome this problem, the Corvallis version of the cylinder features a partially contacting vinyl backing with a stiff-bristled brush poking through the area of the cylinder where the indentations become perforations. Rotating the brush against the rotating cylinder dislodges any plugged seed.

Joseph Park and Norman Brandenburg are located at the Agricultural Utilities Bldg., Oregon State University, Corvallis, OR 97331.—(By Lynn Yarris, Oakland, Calif.) ■



**Top:** A vibrating trough conveys uncleaned seed into the cylinder; a chain drive rotates the cylinder counterclockwise. The cleaning brush, which keeps indents unclogged, sits directly on top of the cylinder and is driven by friction in the opposite direction. (PN-6849)

**Left:** Oregon State University engineer Thomas McNeil Cooper looks for clogged indents in the seed separator cylinder. (0381X329-6a)

**Right:** These different sizes and shapes of seeds show the difficulty of designing a seed separator that will separate seeds from contaminants. (0381X329-15a)

# Sewage Plus Nuclear Waste Equals Cattle Feed

Raw sewage solids and nuclear wastes may prove to be compatible.

Irradiating the raw solids with nuclear wastes turns a potential pollutant into a useful supplementary livestock feed that may also solve a particular problem for range cattle in the arid Southwest.

Irradiation kills any possible disease germs and viruses in the dry sewage, does not alter the makeup of the solids, and causes no radioactivity in the material. While the sewage contains much usable protein, of equal importance is that it also contains trace minerals, particularly copper, manganese, and zinc.

Those three minerals are either lacking or somehow become unavailable to cattle during the Southwest winter, when range grasses are dormant. Adequate amounts of the minerals through supplementary feeds, studies show, increase the number and weight of calves weaned and speed up the rebreeding of cows.

ARS range scientist Carlton H. Herbel and New Mexico State University animal nutritionist G. Stanley Smith have been studying mineral deficiency on ARS's 190,000-acre Jornada Experimental Range near Las Cruces.

The scientists divided a herd of 74 cattle into three groups. They fed one group of 25 a supplement of cottonseed meal, the other group of 25 the sewage solids in pelleted form, and the group of 24 no supplements. All of the cattle grazed the dormant range grasses as well.

The sewage supplement is 50 percent sewage solids, 23 percent cottonseed meal, 15 percent alfalfa hay, 10 percent molasses, and about 2 percent apple flavoring. At the time of the study, it cost about $80 a ton; cottonseed meal, a standard supplement, cost about $200 a ton.

During the period of the study, 3 months in 1978 and 2 months in 1979, cattle were fed about 4 pounds of supplement per head per week. During that time, when the range grasses are at a nutritional low point, cows are in late stages of pregnancy or have calved and are producing milk.

Percentages of "calf crops" for the 2 years of study were 66 percent for the cows getting no supplement, 84 percent for the cows getting cottonseed meal, and 82 percent for the cows getting the sewage solids supplement.

Average weights of the calves at weaning for the 2 years were 274 pounds for the no-supplement group, 330 pounds for the cows fed cottonseed meal, and 308 pounds for those fed the sewage product.

After the calves were weaned, the cows were rebred. Only 61 percent of the group that had no supplements became pregnant, while 88 percent of the cows that had received supplements became pregnant.

All of the groups had nearly the same amounts of silver, cadmium, chromium, iron, mercury, nickel, and lead in blood, liver, and milk; moreover the sewage solids tended to improve low levels of copper, manganese, and zinc in blood and milk.

"Our results support and tend to confirm the view that products derived from raw sewage—primary sludge—could be recycled as supplemental feeds for ruminants subsisting on poor quality roughage feeds.

"Substantial nutritive benefits are provided by the sewage products without incurring undue risk from toxicity to animals or accumulation of toxicants such as heavy metals.

"Naturally, further research is necessary before feeding of sewage products could be recommended in practical livestock production," Herbel and Smith say.

Carlton H. Herbel is located at the Jornada Experimental Range, P.O. Box 698, Las Cruces, NM 88001.—(By Paul Dean, Oakland, Calif.)■

# Flat Breads on the Rise

Flat bread production in the United States may be on the rise. ARS evaluations showed soft white winter wheats from the Pacific Northwest to be ideally suited for the production of flat or pocket-type breads.

More than half the caloric intake of more than half the world's nations comes from bread, and internationally, flat breads are more popular than western-style loaf breads.

In a project funded by the Oregon, Washington, and Idaho Wheat Commissions, ARS food technologists Gordon L. Rubenthaler and Patrick L. Finney, along with visiting scientist Hamed Faridi, all at Pullman, Wash., evaluated the potential of soft white wheat for making flat breads.

Soft white wheat produced a less chewy and lighter bread, desirable characteristics in flat bread. Because of the bread's flatness, the lower gluten strength of soft white wheat became an advantage. The wheat's use in flat bread was also shown to be improved with the addition of 65 parts per million ascorbic acid and 0.25 percent of malt.

The ARS researchers believe that the domestic market for flat breads is potentially strong as well, because these breads are nutritious and feature fewer calories and more fiber than conventional loaf breads.

"Flat breads contain no sugar or shortening or milk, just flour, yeast, and water, a very simple formula," says Rubenthaler. "They are easy to make and taste good."

The researchers are continuing to evaluate wheat and flour requirements for flat breads and hope to soon be using an infrared reflectance device for quick and simple quality tests.

Gordon L. Rubenthaler and Patrick L. Finney are located at the ARS Western Wheat Quality Laboratory, Wilson Hall, Washington State University, Pullman, WA 99164.—(By Lynn Yarris, Oakland, Calif.)■

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# Agrisearch Notes

**Seeding Forages Earlier in the Northern Plains.** Planting perennial forages in late summer, rather than early fall, ensures less winter damage, better summer survival, and greater growth the next season, says Richard S. White, ARS plant physiologist at Miles City, Mont.

White, along with range scientist Pat O. Currie, studied field plantings of crested wheatgrass, pubescent wheatgrass, and Russian wildrye, all common range grasses. They found that winter injury was less severe for larger plants of all three species. Planting in late summer gave seedlings time to develop three or more leaves before winter dormancy. This gives forages a better chance for surviving the harsh environmental conditions of the Northern Plains.

Although much research has been conducted on forage establishment, little has been done on how the early growth and development of seedlings fit into range production.

Early seedling growth and development are critical because the youngest plants are the most vulnerable to winter injury, desiccation, competition, and grazing. The researchers are examining ways to get introduced species into forage production as early as possible.

"The sooner ranchers can move cattle onto more productive, new ranges, the more efficient will be beef production," says Currie.

Richard S. White and Pat O. Currie are located at the Livestock and Range Research Station, Route 1, Box 2021, Miles City, MT 59301.—(By Dennis Senft, Oakland, Calif.)

**Searching for Tobacco Budworm Resistance in Cotton.** Cotton strains with resistance to the tobacco budworm can be identified with less time, trouble, and expense, thanks to methods developed by three ARS scientists. In an effort to streamline the identification process, geneticist J. N. Jenkins, entomologist W. L. Parrott, and agronomist J. C. McCarty, Jr., developed a way to apply larvae in large numbers uniformly to thousands of cotton plants daily.

Working with mass-reared tobacco budworm pupae from the USDA-ARS Bioenvironmental Insect Control Laboratory at Stoneville, Miss., the scientists are able to produce up to 275,000 larvae daily. Pupae containers, adult cages for oviposition, and egg collection equipment were modified from the designs of Jack McWilliams, research entomologist, of the Stoneville Laboratory.

To produce the larvae efficiently from these pupae, the researchers built an 8- by 12-foot building equipped with an air conditioner and humidifier to provide a stable environment.

In the building, adult moths hatch from the pupae and lay eggs on screens. The screens are removed and then gently shaken by an electric motor in a wash that removes the eggs. These are collected, dried, weighed, and placed in gallon jars along with corncob grits (a dispersal agent) and a sheet of hexacell (a manmade honeycomb that increases the surface area available and helps to keep the larvae from sticking together in clumps).

The production of the larvae is almost completely mechanized; getting the larvae on the cotton plants, however, requires a crew of assistants.

One assistant can inoculate 1,000 plants per hour using plastic inoculators which screw onto bottles filled with the mixture of corncob grits and newly-emerged larvae.

The inoculators measure out a uniform number of larvae onto the terminal of the cotton plant—exactly where they appear in naturally infested cotton. One application contains about 12 larvae, each about the size of the comma on a typewriter.

The research group works with hundreds of thousands of plants. But, according to Jenkins, commercial plant breeders could adapt and expand the system to their vastly larger operations.

Moreover, the system could be adapted for use on crops other than cotton.

The research group is located at the ARS Crop Science and Engineering Research Laboratory, P.O. Box 5367, Mississippi State, MS 39762.—(By Bennett Carriere, New Orleans, La.)